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Diagnostic and Predictive Measures in the Teaching of Reading in Sweden.

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Swedish children, who receive extensive readiness activities in their first months in school, are taught through a diagnostic approach which involves observation, diagnosis, and treatment of difficulty by the classroom teacher. Results of a 6-year longitudinal study of the system revealed (1) the degree of success achieved by a program of remedial instruction coupled with the regular curriculum and (2) the reliability of reading readiness test batteries and perception tests for measuring reading readiness. Classes were divided into experimental and control groups, with the experimental groups receiving remedial instruction from a special teacher. The differences between the two groups were studied by, among other methods, analysis of covariance. Subtest scores of readiness tests were found to be significant contributors to analysis of readiness. The readiness variable was found to have the highest prognostic value of all measures considered. And the combination of early diagnosis and remedial instruction was found to have a positive effect on the children involved. Tables of results and explanations of their meanings are included. (MD)

A "make haste slowly" policy permeates the teaching of beginning reading.

In Sweden it is held that growth in reading, as growth in other learnings, cannot be hurried without some undesirable, and even damaging, effects on some children. Therefore, we try to make the transition from home to school as easy as possible by having the children go to school for only two hours a day the first two or three weeks of school, and in groups of no more than 12 or 13 children. The teacher is doing her best to create in the children positive attitudes toward school and the working life there.

With these beginning seven-year olds we are of the opinion, that it pays to "waste time"; to start very easily, introducing a variety of reading-readiness exercises and using materials, for many children on a difficulty level rather far below their capacity level. This "make haste slowly" policy permeates the teaching of beginning reading in Sweden.

Even if the majority of children might be ready to be taught reading when they start school, there are always some who, for different reasons, have not reached the desired readiness level. It is considered unrealistic to expect that these children will make normal progress in reading. Whatever the reasons are for their lack of readiness the school must let them get a calm and cautious start in reading. Otherwise, these children run a big risk of becoming "failures" and of getting a lifelong dislike of reading.

A diagnostic approach is recommended.

Children of the same chronological age differ widely in capacity to learn, intelligence, background experiences, and all kinds of personality traits. Research workers all over the world are in agreement on this.

My own investigations of first grade children in Sweden discovered a range from four years and eleven months to eleven years and eight months in mental age, while differences between the children's chronological ages were very small.

The variance within the same class as regards even other variables was found to be equally extensive. The need of organizing instructions to provide for these differences between and within children as to resources in various respects is therefore evident and urgent.

As a consequence of research results of the kind I have mentioned, the school authorities have recommended a diagnostic approach and as far reaching an individualisation of the teaching of reading as possible.

The procedure on principle for an efficient special teaching and treatment of a child with potential reading disabilities will be as follows:

1. Diagnostic measuring steps.
2. Teaching and treatment based on the results of the tests used.
3. Renewed diagnostic testing.
4. Continued testing and treatment from time to time modified according to the test results, etc.

The diagnosis is not to be considered as finished as soon as it has been carried out in the beginning of a teaching period. It is supposed to go on all the time the teaching is going on - day by day, week by week.

In theory most teachers in Sweden accept this view by now, even if for various reasons it is far from generally put into practice.

already at the school start in grade 1 and by the immediate establishment of a teaching situation synthesizing ongoing diagnosis - treatment - and remedial teaching for those children who on the basis of the diagnostic findings could be expected to experience special reading and writing disabilities when offered only ordinary teaching facilities.

By the use of specially constructed test batteries it is possible to put forward a much more reliable prediction than before as regards the development of the children's reading ability and to decrease to a considerable extent the error margin in the selection of pupils needing remedial teaching in a reading clinic.

Those are some of the results which I have recently presented in a final research report to the Royal National Board of Education in Sweden. The studies I have reported on are of a longitudinal type. They have been ongoing for six years. The pilot study comprised twenty classes with a total of 386 pupils and the field experiments included seventy-two classes with a total of 1653 pupils from 12 cities in various parts of the country.

If each child is to be given tasks suited to its level of maturity, tasks that he can tackle successfully, there must be, among other things, instruments available to make a satisfactorily correct diagnosis of the stage of development and maturity of individual beginners possible.

The results of conventional school readiness tests may to a certain extent give some guidance for the individualization of instruction which is considered especially important for beginners. But the investigations have shown that ordinary school readiness tests, administered before the beginning of schooling in grade 1, have proved to be only moderately correlated with the results of reading and writing tests, given

after one year or more of school attendance. The coefficiants of correlation are usually between + 0.40 and + 0.50. These tests are consequently not very reliable prediction instruments if used without supplementary procedures.

The reliability of prediction instruments raised to a considerable extent.

But from the results of my now reported studies the conclusion can be made that if school readiness tests are complemented by specially constructed batteries of reading readiness tests and perception tests the reliability of prediction can be raised to a considerable extent, especially if the tested new system with prognoses in several steps is used.

On the basis of the results of the used diagnostic tests it was anticipated that certain children would experience reading disabilities, if no special remedial measures were taken.

From the first school days of grade 1 these children were given special remedial instruction by a reading clinic teacher in cooperation with the ordinary class teacher, if they belonged to the experimental group (the one half of a class).

No remedial instruction of this kind was given to pupils of this cathegory if they belonged to the control group (the other half of the class having the same teacher).

To test the hypothesis that it is possible to reduce considerably the number of cases of special reading disabilities during the first three years at school, the experimental-control group method was applied. The differences between the two groups were studied by, among other methods, analysis of covariance. A series of multiple regression and correlation analyses were made in order to study the prognostic power of

various predictors of reading and writing ability in grades 1 to 3. By means of these analyses it has been demonstrated that the number of the predicting instruments could be considerably reduced with an only negligible deterioration as regards prognostic value.

A group of three variables has been crystallized. Each one can be expected to contribute significantly to good prognosis. First, the battery of reading readiness tests; second, one of the five visual perception tests (visual letter perception); and third, the battery of school maturity tests.

Out of 30 criterion variables registered (10 variables at the end of each of grades 1, 2 and 3) we have calculated, with the use of conventional transformation procedures, composite indexes as regards the following three major groups of variables: reading accuracy, reading comprehension and spelling.

The reading readiness variable gave the highest prognostic values.

Out of the different predictors studied the reading readiness variable has throughout given the highest prognostic values, regardless of which criterion variable was examined. As was expected we found that the accuracy of prediction decreases with increasing grade level (1-3) as regards all types of criteria.

The aim of the remedial teaching has been to prevent or eliminate reading and writing disabilities among pupils in the experimental group.

The criteria, reading accuracy and spelling, seem to be most fitted to indicate reading and spelling disabilities at this level. The fact that the analysis yielded significant group mean differences favouring the experimental group in five cases of six strongly supports the hypothesis that the remedial teaching has

had the expected effect. The noted existance of a region of significance as regards spelling ability in grade 3 at a reading readiness level below +.4 sigma, which was demonstrated by the use of a method of "matched regression estimates" (see Walker-Lev, 1953) gives further support for the hypothesis.

Because this region of significance means that the total experimental group superiority in spelling ability is mainly due to a superiority of experimental group pupils with low or medium initial reading readiness level, id est just those pupils who have been given reading clinic teaching.

I therefore consider the conclusion justified that the remedial teaching has significantly increased both spelling ability and reading accuracy of the "clinic pupils" in comparison with equivalent pupils in the control group.

The results of the investigations also show that the reading clinic teaching contributed to reduce the variance as regards the results on reading and spelling tests among the pupils in the experimental groups in relation to the variances of the same tests in the pupil samples used in the standardization procedures.

Early diagnosis and remedial instruction have a strong positive effect.

In a subpopulation, consisting of pupils from both groups having low initial scores on given tests, a number of criterion variables were subjected to analysis of variance by means of various types of multifactorial designs. The results of these analyses are also interpreted as support for the main hypothesis, that early diagnosis and remedial instruction in reading clinics have a positive effect on the development of both reading and spelling ability.

Table 1. Prediction of different aspects of reading and writing skill at different occasions and for periods of different duration. (Based on data of the Control-group in Exp. Reading - Writing - 161.

Prediction of	Prediction made at	Duration of period in terms	R	R^2	Predictors
Reading accuracy	school start - AT, gr 1	1	.668	.446	Reading Readiness, School readiness, Visual percept. 2.
	AT, gr 1-ST, gr 1	1	.724	.524	Ditto + Reading tests 5a and 7
	ST, gr 1-ST, gr 2	2	.829	.686	Reading accuracy, grade 1
	ST, gr 2-ST, gr 3	2	.922	.851	Reading accuracy, grade 2
	school start - ST, gr 1	2	.507	.257	Reading readiness, School readiness, Visual perception
	ST, gr 1-St, gr 3	4	.774	.600	Reading accuracy, grade 1
Reading comprehension	school start - AT, gr 1	1	.579	.335	Reading readiness, School readiness, Visual percept. 2.
	AT, gr 1-ST, gr 1	2	.767	.588	Ditto + Reading tests 5a and 7
	ST, gr 1-ST, gr 2	2	.745	.554	Reading compreh. grade 1
	ST, gr 2-ST, gr 3	2	.551	.304	Reading compreh. grade 2
	school start - ST, gr 1	2	.622	.387	Reading readiness, School readiness, Visual percept. 2
	ST, gr 1-ST, gr 3	4	.502	.252	Reading compreh. grade 1
Spelling	school start - AT, gr 1	1	---	---	--(criterion not measured in grade 1)
	school start - ST, gr 1	2	.553	.306	Reading readiness, School readiness, Visual percept. 2.
	AT, gr 1-ST, gr 1	1	.647	.418	Ditto + Reading tests 5a and 7
	ST, gr 1-ST, gr 2	2	.700	.490	Spelling, grade 1
	ST, gr 2-ST, gr 3	2	.785	.616	Spelling, grade 2
	ST, gr 1-ST, gr 3	4	.645	.416	Spelling, grade 1

Note:
AT - means end of Autumn Term,
ST - means end of Spring Term.

The frequency of pupils with reading and spelling disabilities was found to be consistently lower in the experimental groups than in the control groups - in the experimental group less than 1 per cent of the population as against the about 5 per cent expected according to the operational definitions used.

Analyses of variance on a multifactorial design.

Analyses of variance were performed on a multifactorial design: 3 intelligence levels (IQ) x 3 initial reading ability levels (IR) x 2 experimental conditions (E, C_1).

The E group was significantly superior to the C_1 group in Reading Accuracy in all three grades and in Spelling in grades 2 and 3.

The analyses yielded no significant values for interactions of experimental condition with IQ level and/or IR level. Some interesting trends were observed, however.

In grade 1 the E group superiority was about the same at all IQ levels - the lower the IR-level the greater the superiority. As regards the potential cases of special reading/writing disabilities (at least normal IQ and low IR level) the E group superiority was rather great in grade 1.

In grade 2 - and - still more - in grade 3, however, the E group superiority was greatest at the two lowest IQ levels and especially great among pupils with a very low IQ and a very low IR level. For potential cases of special reading/writing disabilities the E group superiority was small in grades 2 and 3 - or even non-existant.

Thus, reading clinic instruction seems to be effective in the long run, not only when given to pupils with potential special reading/writing disabilities, (normal IQ and a low level of IR) but also - and perhaps even

more so - when given to pupils identified as potential reading/writing disabilities at a low intelligence level.

The proportions of poor readers and poor spellers (concepts operationally defined) in different cells in the IQ level x IR level x experimental condition design were also computed. The proportions were almost consistently smaller in the E group than in the C_1 group.

It is concluded, that the clinic instruction given to E group pupils, has reduced the frequencies of reading/writing disabilities in grades 1, 2 and 3 respectively. The frequency of reading disabilities was more markedly reduced than the frequency of spelling disabilities.

The predictive power for various criteria and for various prediction periods.

In my report I have also presented an analysis of the reliability of the selection of pupils for reading clinic instruction, based on predictions from collected test data.

The prognostic validity of different test batteries decreases with increasing length of the period of prediction. Therefore, a selection of pupils for clinic instruction based on test data may be made more reliable if successive short-term prognoses are made.

If the first prognosis of reading/writing disabilities is made at the school start, it seems desirable to make new prognoses (based on new data), 1) at the end of the first term, 2) at the end of grade 1, 3) at the end of grade 2.

The predictive power for various criteria and for various prediction periods are given in table 1. The predictive power for short-term prediction is - on the whole - to be considered as good, especially when predicting Reading Accuracy.

Table 2. Maximum risk that a pupil with a criterion value below a given critical level will not be assigned to a reading clinic at selections of different size (in per cent) on the basis of used predictors.

a) Risks of error when the 20 per cent worst according to combined predictor measures are assigned to reading clinics (i.e. $z_{p(x)} = -0.84$)

Time of prediction	Duration of prediction period in terms	Critical value in criterion variable ($z_{p(y)}$)			
		-2.5 (p(y)=.006)	-2.0 (p(y)=.023)	-1.5 (p(y)=0.67)	-1.25 (p(y)=.106)
Schoolstart	1	.005	.03	.10	.18
Autumn gr 1	1	.003	.02	.10	.18
Spring gr 1	2	.0006	.01	.08	.16
Spring gr 2	2	.000004	.0008	.03	.11

b) Risks of error when the 15 per cent worst according to combined predictor measures are assigned to reading clinics (i.e. $z_{p(x)} = -1.4$)

Time of prediction	Duration of prediction period in terms	Critical value in criterion variable ($z_{p(y)}$)			
		-2.5 (p(y)=.006)	-2.0 (p(y)=.023)	-1.5 (p(y)=.067)	-1.25 (p(y)=.106)
Schoolstart	1	.008	.04	.14	.23
Autumn gr 1	1	.006	.04	.14	.24
Spring gr 1	2	.002	.02	.13	.24
Spring gr 2	2	.00003	.003	.08	.22

c) Risks of error when the 10 per cent worst according to combined predictor measures are assigned to reading clinics (i.e. $z_{p(x)} = -1.28$)

Time of	Duration of prediction period in terms	Critical value in criterion variable ($z_{p(y)}$)			
		-2.5 (p(y)=.006)	-2.0 (p(y)=.023)	-1.5 (p(y)=.067)	-1.25 (p(y)=.106) [1]
School start	1	.01	.06	.19	--
Autumn gr 1	1	.01	.06	.20	--
Spring gr 1	2	.005	.05	.22	--
Spring gr 2	2	.0003	.02	.21	--

1) At a 10 per cent selection it is not meaningful to calculate the risk of error at this critical value, for it would imply that p(y) would be greater than p(x), i.e. that even fewer than desired would be selected.

The reliability of a selection of pupils for instruction in clinics is also studied through an analysis of risks of error in selection. "Risk of error in selection" is defined as the risk that a pupil is not selected for instruction in a clinic, although according to accepted criteria he is in need of such instruction.

At a given critical value in the criterion variable (expressed conveniently in z-scores), the extent of the risk of error at different percentages of a year group assigned to reading clinics can be calculated.

The calculations are based on the assumption of normal distribution in predictors and criteria and of homoscedasticity,

if $z_{p(x)}$ indicates the point of intersection in the distribution of the combined predictor values in the selection of the p per cent worst in this distribution to instruction in clinics;

$z_{p(y)}$ indicates the critical value in the criterion distribution, corresponding to the desired selection of the p (y) per cent worst in the criterion variable;

$z_{p(e)}$ indicates the z-value for risk of error

then

$$z_{p(e)} = (x_{p(y)} - x_{p(x)} R) / \sqrt{1 - r^2}.$$

The value required (p(e)) is then the proportion of the normal distribution lying to the right of $z_{p(e)}$.

Table 2 gives the risks of error for various critical values in the criterion variable at different percentages of pupils selected for instruction in clinics.

A minimization of the risk of error analysed here implies, of course, an increase in the risk of the opposite type of error, i.e. that pupils are assigned to reading clinics although they do not really need such instruction. Selection errors of this type can easily be corrected later, by simply removing such pupils from the clinic.

The critical values in the criterion variable given in table 2 (-2.5, - 2.0, -1.5 and -1.25 z) were chosen to illustrate the risk of pupils with different degrees of reading disability not being selected for remedial instruction in clinics.

At the critical values -2.0 and -2.5 the risks of error are 6 and 1 per cent respectively. The risks of error for the first period (school start) are, it is true, consistently greater than the corresponding risks during other periods.

At an assignment to clinics of 20 per cent of the pupils at the start of school for a selection of the more pronouncedly poor readers (criterion values below -1.5) the maximum risk of error is never greater than 10 per cent, however.

It should be observed that the choice of criterion in this analysis - measures of reading accuracy - implies that selection to reading clinics comprises pupils with potential reading disabilities independent of the level of general intelligence. No special analysis of risks of error in the selection of pupils with special reading disabilities (as defined earlier in this paper) has been considered necessary. There were two main reasons for this: (a) the pupils with special reading disabilities are included in the group of poor readers of all intelligence levels, for which reason the risk of error for the former group need not be assumed to be greater than for the latter, and (b) the analysis of the effects of reading clinic instruction reported earlier showed that there are no

strong reasons why instruction in reading clinics should be given only - or even preferably - to pupils with special reading disabilities.

To sum up, therefore, it may be said that the risk that a pupil, needing instruction in a reading clinic, will not be assigned to such a clinic, can be kept at a low level,

if selection of pupils is checked and corrected at regular intervals during the first three years of school by the help of instruments of the kind tested here, and

if available places in clinics are distributed so that a certain "surplus selection" is made in the first grade during the first term.